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Perceptions of multi-stresses impacting livelihoods of marine fishermen

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ABSTRACT

Multiple stresses adversely affect fish catch and livelihoods of marine fishermen. Perceptions regarding these stresses in the fishing community can vary, which can consequently determine adaptation responses. However, there are limited attempts to understand these perceptions and the factors which might be influencing them. This study, first, identifies the specific stresses impacting livelihoods of the fishing community in Maharashtra (India) through the literature and Focus Group Discussions. Thereafter, a household survey is used to examine the factors influencing the perceptions of these stresses. Further, a composite stress perception index, comprising of two factors representing climatic and non-climatic or general stresses, is built. The index suggests that a majority of the community perceive greater risks from the non-climatic stresses compared to changes in temperature and rain. It is found that the perception of stresses varies significantly with the regional background. However, the relation of various other socio-economic factors is not uniform with the perceptions of different stresses. This study is one of the first to comparatively analyze climatic and non-climatic stresses in fishing, and suggests the need for effective implementation of current policy measures to reduce the stresses along with awareness generation regarding impact of climate change in the community.

1. Introduction

Marine ecosystems are threatened by multiple stresses, including pollution, trawlers, habitat loss and climate change, which can adversely impact fish populations [1]. This has consequently affected marine fish catch and fishing livelihoods around the world [2–5]. Awareness or perceptions regarding livelihood stresses can play a significant role in communities' decisions to adapt to them [6]. Thus, it is important to understand the multitude of factors that might be influencing these perceptions.

Studies which empirically assess factors associated with perceptions of risks, such as climate change and other environmental stresses, among farmers [7–10] and general public [11,12] exist. There are also qualitative studies describing factors influencing perceptions of livelihood risks in communities [such as [13,14]]. In the literature on fishing, few earlier studies [15,16] describe the health risk perceived by fishermen because of (mercury and other chemicals) contamination in their fishing sites. But, these studies do not report stresses/risks which can affect the livelihoods of the community. Nursey-Bray et al. [17] is one of the rare studies which presents the perceptions of climate change risks and its impacts on the livelihoods of lobster fishers in Tasmania. They found that the fishermen's perceptions are distant from the scientific observations on climate change in the region. On the other hand, a recent study [18] in Brazil showed that fishermen perceive some of the livelihood stresses such as changes in rainfall, air and ocean temperatures in accordance with the scientific evidence. But again, these are descriptive studies and do not assess the factors which can lead to such perceptions. In India, Karnad et al. (2014) [19] analyzed perceptions of declining catch and the factors driving them. The study, however, did not examine perceptions of stresses leading to this decline. There are also few studies, in other Asian countries such as Bangladesh and Philippines, on perceptions of the fishing community about changes in fish catch [20], productivity [21] and their drivers [20]. Overall, attempts to understand perceptions of livelihood stresses in marine fishing and their associated factors are limited. The present study aims to fill this knowledge gap by examining the perceptions of multi-stresses which might be impacting catches of marine fishermen and the socio-economic factors influencing them. This study contributes to the literature on livelihood risks and has implications for designing awareness generation programmes. Awareness and perceptions of stresses can consequently affect adaptation decisions in communities [22].

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Multiple stresses, that is, increasing pollution, trawlers, decreasing mangroves and climate change are considered in this study. Impacts of pollution, trawlers and declining mangroves on marine ecosystem have been discussed in the literature [1,4,5] as well as widely in public reports/media. But, while a bulk of scientific literature indicates the impacts of climate change on marine fishing [2,23,24], it is hardly discussed in the media, especially in developing countries like India. It seems that impacts of climate change on marine fishing have not been highlighted as an issue of concern among the general public. Thus, it becomes all the more important to understand fishermen's perceptions specifically about climate change as well as relative to other stresses, and the factors affecting them. Findings of such analyses can help design climate change awareness programmes for fishing communities. Further, climate change is generally studied through patterns of change in temperature and rain [25]. Thus, this study attempts to analyze perceptions of climate change and also its constituent parameters, that is, temperature and rain, among marine fisherfolk. Agglomerating the perceptions of the multiple stresses, a composite 'stress perception index' is also built in this study. This is done to further investigate the factors influencing the overall perception of stresses. Also, as it is a weighted index, it is helpful to understand the relative perceptions regarding climatic and non-climatic/general stresses in the fishing community.

This study analyses the perceptions of marine fishermen in the state of Maharashtra, India. Maharashtra is a coastal state in western India along the Arabian Sea. The focus of the paper is specifically on the stresses which can impact fish catch of the community in the area. The next section describes the conceptual framework of the study, which includes a detailed account of the stresses in the region according to the literature and the community. It also presents the socio-economic factors which might influence perceptions of stresses, as identified from the literature. Section 3 pertains to the data and methods used in the study. The results are presented in Section 4. The paper concludes in Section 5.

2. Background and conceptual framework

2.1. Evidence of stresses in the study site

The various stresses which persist in the area and affect fish catch of the community are identified both through the literature and Focus group Discussions (FGD) with the community. The FGDs are used to evaluate if the stresses noted in the literature are experienced by the community in actuality. This helped in identifying the stresses which are hindering the livelihoods of marine fishermen based specifically in the study sites. These insights from the literature and FGDs are discussed in the following two sub-sections.

2.1.1. From literature

The literature indicates that pollution in the sea, declining mangroves, increasing trawlers and change in climate can adversely affect fish population and catch [1]. An extensive review of the literature by Islam and Tanaka [4] shows that aquatic pollution (from chemicals, sewage, oils, metals, organic compounds and plastics) has had detrimental effects on the marine ecosystem around the world. This includes loss of habitat, mortality, decline in species diversity and population. Nagelkerken et al. [5] has showed through their review that mangroves serve as spawning sites and habitat for various marine species and hence, its destruction has resulted in lowering fish catch in many regions. Trawlers, too, wreck the marine ecosystem by trapping non-target specie and juvenile fish, thereby resulting in large quantity of by-catch [26] and affecting catch of other fishermen [27]. As climate change can alter ocean temperatures, it can affect ocean primary productivity and change distribution and abundance of marine fish species [2]. Change in rainfall can also influence fish population [28] as spawning periods can correspond to monsoon [29,30].

Studies which provide evidence of various stresses being prevalent in the sites of the current study are described in Table 1.

2.1.2. From focus group discussions

Three FGDs with marine fishing communities located in urban, semi-urban and rural areas of Maharashtra[1] helped in understanding the communities' perception about the stresses identified in Section 2.1.1. Each FGD included 10–15 fishermen who have been engaged in fishing since the last 5–40 years. The communities were also enquired about any other stress which they might perceive to be affecting their fish catch. It is found that the stresses experienced by the communities in the study area mostly align with the literature (except in case of mangroves). The FGDs further assisted in obtaining any other relevant details regarding the stresses.

The FGDs revealed that the communities' strongly feel sea pollution to be the most important stress impacting their livelihood. The seas have become highly polluted in the past years. Effluents from cities, industries, ports and oil rigs are the major contributors to pollution in the seas, according to the communities. Pollution has majorly affected availability of fish. Debris in the sea also damage their fishing nets.

The semi-urban fishing community seemed to be the most concerned about the destruction of mangroves. Mangroves are fish habitats and are important locations for spawning. Destruction of mangroves because of various developmental activities has severely affected fish populations. Although the literature indicates that mangrove cover in Maharashtra has increased in recent times [35,36], the communities perceived that they have declined and have been impacting their livelihood. These perceptions are especially prevalent among the older generations of the community. Additionally, pollution, in the form of chemicals, sewage, plastics and other debris, has affected the mangroves.

All the three groups perceive trawling to be a destructive method of fishing. They perceive that such methods of fishing should be regulated, through seasonal bans and restrictions on owning multiple trawlers by a single fisherman.

The fishing communities perceive changes in climate. Temperature has increased, and rain has decreased accompanied by delays in monsoon. All the communities noted that change in rainfall and delays in monsoon affect fish spawning which consequently affects their livelihoods. The communities also perceive that increase in temperature can affect distribution and availability of fish species. However, during the FGDs only a limited number of participants of the three communities, who were experienced and aged, were able to explain the effect of temperature on fish distribution. They described that fish population change their spatial location and depth in the sea according to temperature. However, they were not able to gauge the effects of declining chlorophyll, resulting from warming as noted from the literature [49,50], on fish populations.

Thus, based on the literature and FGDs, the following stresses are identified to be affecting the communities in the study sites: *(i) increase in pollution, (ii) decrease in mangroves, (iii) increase in trawlers, (iv) change in climate, including (v) increase in temperature and (iv) decrease in rain.*

2.2. Identifying factors driving perception of stresses

According to the 'risk perception' literature, various socio-economic factors can shape perceptions of stresses (impacting livelihoods) of individuals. The factors specifically tested for their association with perception of different stresses in this study are discussed in the following paragraphs. They include: *(i) region, (ii) level of education, (iii)*

[1] The FGDs are held with communities with different regional backgrounds, as 'region' is considered to be a factor affecting perception of stresses in this study. The details are described in Section 2.2.

Table 1
Stresses in the study site as observed from the literature.

Stress	Description
Pollution	The Arabian Sea near Maharashtra is one of the most polluted in the world [31]. This includes pollution from sewage [32], plastic [33]and oil leaks [34].
Mangroves	Maharashtra has experienced one of the highest increase in mangrove forest cover of around 46 km^2 since 1987–2015 in India [35,36]. This has been possible because of the current initiatives of the Government of Maharashtra, such as setting up a specialized Mangrove Conservation Cell and classification of mangroves as reserved forests [37]. The city of Mumbai had experienced decline in mangrove cover during the last decade [38–40]. But in 2011, mangroves had increased to 11.7% of the city's total area [38]. On the other hand, there have been studies which report that mangroves have decreased in pockets of Raigad district of Maharashtra [41].
Trawlers	All the districts of Maharashtra have seen a rise in the number of trawlers. It is reported that total number of trawlers in the state have increased by 33% from 2005 to 10 (4219–5613 trawlers in 2005 and 2010 respectively) [42,43]. Trawlers have damaged the marine ecosystem in the state [44] and have resulted in declining catches [45].
Climate change	The Arabian Sea has been experiencing warming after 1995 [46,47]. Further, a temperature rise of approximately 1 °C is observed in the Arabian Sea over 1950–2005 [48]. This has resulted in decline in concentrations of chlorophyll in the Arabian Sea, indicating decreasing primary productivity which can affect marine fish populations [49,50]. Further, the Indian Seas are identified as warming hotspots and are expected to warm by 4 °C by 2099 [51]. Studies have also observed variability [52]and weakening of monsoon winds over the Arabian Sea [53].

years of experience in fishing, (iv) number of family members who fish together, (v) income from fishing, (vi) type of boat, (vii) average length of one fishing trip, (viii) number of fishing months in a year, and (ix) whether or not fishermen know to use the internet. These form the independent variables in the regression analyses as described later in Section 3.2. These variables are proposed based on insights from previous literature.

Regional background of an individual can predict levels of awareness about stresses such as climate change [11]. Studies [11,54] have found that urban populations can be more aware about risks from climate change compared to rural communities. This can be because of greater access to information in urban areas. The urban-rural divide can be particularly significant in developing countries like India where regional backdrops can define overall socio-economic characteristics of individuals [55,56]. Further, urban areas have been facing environmental stresses, such as pollution and land use/cover change, for a comparatively longer period of time than rural areas [57]. Such differences in experiences and socio-economics based on region can affect perceptions of stresses.

Education has been widely used as a determining variable of perceptions of risk [7,9,11,58]. Education can improve access to information and networks, and hence can be positively associated with perceptions of risks [7,11]. However, studies have also found it to be negatively associated with perception of stress, such as change in rainfall [9] and global warming [59]. Thus, the current study assesses the influence of various levels of education on perception of stresses impacting the fishing community.

Greater number of years of involvement in one's livelihood can help perceive changes over time. Thus, risks or stresses can be perceived more by experienced fishermen. For example, Gbetibouo [9] found that farmers with more experience were more likely to perceive changes in the temperature. However, the study found no significant link of experience with perception of change in rainfall and climate. On the other hand, Roco et al. [7] observed that climate change is perceived more by younger farmers. Thus, associations between experience and perceptions can also be mixed.

Further, factors such as ‘average length of a fishing trip’ and ‘number of months spent in fishing in a year’ can also indicate levels of involvement in marine fishing. Hence, they might also affect perceptions of stresses in fishing livelihoods.

Greater participation of close family members in fishing might help perceive stresses better. This is because of collective observation of changes and stresses impacting livelihoods over time. Participation of family members is a form of social capital which can increase sources and exchange of information [60,61]. Sharing of experiences and observations of stresses might influence one's perceptions. However, the literature lacks clear evidence on influence of social capital on perception of stresses. Similarly, usage of technology, such as internet, can provide access to varied sources and type of information [62] which can in turn affect perceived livelihood stresses [7].

Income can be an important determinant of risk perceptions. In case of general perceptions about risks, for example from climate change, people with higher income might perceive lower risks [63]. This is because higher economic capital allows better coping measures to any impact. But, in case of risks/stress affecting livelihoods, income may be positively related to their perceptions. Studies [7,8] have found that individuals with higher income from their livelihood perceive greater risks. This might be because of the associated greater stakes of higher earners with their livelihood. These studies [7,8] have also noted that, as farmers' land ownership and size can indicate higher stakes, they may too be linked to perceptions of risks. Similarly, in the present study, fishermen who own higher priced boats might perceive more stress impacting their livelihood. Hence, it is examined if ‘income from fishing’ and ‘type of boat owned’ is associated with stress perceptions among fishermen. Additionally, the fishing practices of fishermen with different boat types can vary. For example, fishermen with motorized boats can fish over a larger geographical area compared to non-motorized boats. Mechanized boats are the technologically most advanced (with the ability to mechanically cast nets over large areas) and may allow a greater catch. These differences in applicability can also lead to diverse perceptions of stresses among fishermen with different boat types.

3. Data and methods

3.1. Survey

Data for the statistical analysis is collected through a household survey conducted across fifteen fishing villages located in urban, semi-urban and rural regions of Maharashtra, India. The responses are collected through a stratified random sampling approach. A total of 601 responses are obtained, inclusive of 200 responses from urban and rural each, and 201 from semi-urban region. The survey sites are shown in Fig. 1. During the survey, the heads of the households, who are currently involved and go into the sea themselves for fishing, are interviewed. The survey was conducted in the regional Marathi language. The respondents are enquired regarding their observations on change in fish catch and the stressors which might be affecting it. These stresses include: increase in pollution, decrease in mangroves, increase in number of trawlers and change in overall climate. Additionally, they are probed about their perceptions of change in constituent climatic variables, that is, temperature and rain. Further, information regarding the factors (discussed in Section 2.2) which might be associated with the community's perception of these stresses are also collected.

3.2. Statistical analyses

Regression is utilized to understand the factors associated with the perceptions of various stresses as well as a composite index based on

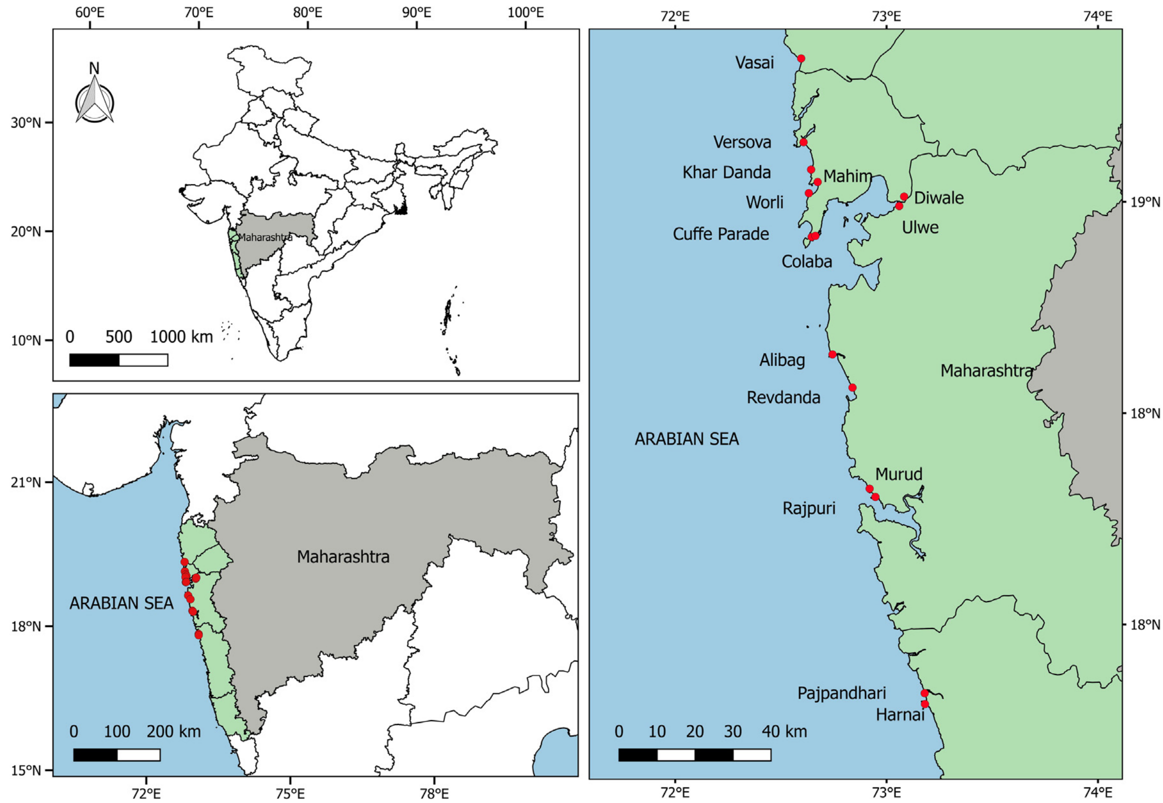

Fig. 1. Location of the survey sites (Reprinted from [22] with permission from Elsevier).

these stresses.

3.2.1. Independent variables

The independent variables in the regressions are various factors (discussed in Section 2.2) that might affect perception of these stresses. The variables of the regression, along with their type and descriptive statistics, are listed in Table 2. The sample is almost equally distributed over urban, semi-urban and rural region. Most of the respondents (37.8%) are educated till the primary level. Percentages of non-motorized and motorized boats are the lowest (10%) and highest (52.9%) respectively. 26.5% of the sample knows to use the internet. The average experience, number of family members who fish together and monthly income from fishing are 24.3 years, 0.5 and INR 20,872.5 (324.1 USD) respectively. Average number of fishing months and length of a fishing trip across the respondents are 8.7 months and 55.3 h respectively.

Before the regression analysis, all independent variables are checked for multicollinearity. As all correlations and Variance Inflation Factors (VIF) are less than 45% and 2 respectively, all variables are retained in the regressions.

3.2.2. Perception of stresses as the dependent variables

Binary logistic regression is applied to assess the association of different variables with the perception of stresses. The dependent variable is binary indicating if the respondent perceives the stress to be present and affecting his fish catch. Six regression equations are estimated for each of the stresses. These stresses are: increase in pollution, decrease in mangroves, increase in number of trawlers, change in climate, and change in the constitutent variables of climate, that is, increase in temperature and decrease in rain. Further, the marginal effect for each of the independent variable in the regressions is also calculated. This is done to assess the change in probability of perceiving the stress with unit change in the independent variable.

3.2.3. Making a composite stress perception index

A stress perception index for each of the respondent is calculated by combining factors extracted from the perception of the various stresses. This composite index is developed using Categorical Principal Component Analysis (CATPCA). The stresses considered for building this index are: increase in pollution, decrease in mangroves, increase in trawlers, increase in temperature and decrease in rain. Change in climate is excluded from this index as temperature and rain, which are constituent variables of climate, are already considered. The factors with eigenvalues greater than 1 are taken. The loadings of the variables on each of the factors are linearly combined to get the factor scores for each of the respondent (Eq. (1)). The final stress perception index is obtained by weighing the factor scores according to the variance accounted by each of them and aggregating them (Eq. (2)). Thus, this index is an amalgamation of two factors (rather than simply choosing the first factor generated in PCA). This approach allows reduction in biasedness in choosing the prominent variables of the index, as it incorporates the varied weightages of the factors representing the different variables.

$$FS_{jk} = \sum_{i=1}^{5} L_i X_{ik} \tag{1}$$

where FS_{jk} is the score of factor j for respondent k

L_i is the loading of variable (perception of stress) i

X_{ik} is the binary variable indicating the perception of the stress i for respondent k

$$Index_k = \sum_{j=1}^{m} (V_j/V_t)^* FS_{jk} \tag{2}$$

where $Index_k$ is the stress perception index for respondent k

V_j is the variance explained by factor j

V_t is the total variance explained by m factors

Table 2
Descriptive statistics of (a) categorical and (b) continuous variables.

(a) Independent Categorical Variables	Type	Sub-categories	Frequency (%)
Region	Nominal	1 = Urban	33.3
		2 = Semi-urban	33.4
		3 = Rural	33.3
Level of education	Ordinal	1 = Illiterate (0 year)	10.6
		2 = Literate without educational level (0 years)	2.7
		3 = Below Primary (1–3 years of school)	14.1
		4 = Primary (4–8 years of school), Class 1–4	37.8
		5 = Middle (9–12 years of school), Class 5–8	25.0
		6 = High school / Secondary, Class 9–10	4.5
		7 = Matriculation (Cleared class 10)	2.5
		8 = Higher secondary, Class 11–12	1.0
		9 = Cleared Class 12	0.7
		10 = Graduate;	0.8
		11 = Post graduate	0.3
Boat type	Nominal	1 = Non-motorized	10.0
		2 = Motorized	52.9
		3 = Mechanized	37.1
Know to use internet	Binary	1 = Know to use internet (The frequency in the next column indicates the percentage of respondents who are scored 1); 0 = Otherwise	26.5
Dependent Categorical Variables	**Type**	**Sub-categories**	**Frequency (%)**
Increase in pollution	Binary	1 = Perceives the stress (The frequency in the next column indicates the percentage of respondents who are scored 1); 0 = Otherwise	87.0
Decrease in mangroves	Binary		35.1
Increase in trawlers	Binary		89.7
Change in climate	Binary		84.0
Increase in temperature	Binary		68.6
Decrease in rain	Binary		27.8

(b) Independent Continuous Variables	Mean	Standard Deviation	Minimum	Maximum
Years of experience	24.3	9.6	5	60
No. of family members who fish together	0.5	0.7	0	6
Income from fishing in INR per month	20,872.5 (324.1 USD)	13,092.2 (203.3 USD)	500 (7.8 USD)	90,000 (1397.7 USD)
Length of a trip in hours	55.3	79.6	1	360
Number of fishing months in a year	8.7	1.6	2	12
Dependent Continuous Variables	**Mean**	**Standard Deviation**	**Minimum**	**Maximum**
Perception of stress index	0.9	0.4	0.00	1.5

3.2.4. *Composite stress perception index as the dependent variable*

Association of the stress perception index with the independent variables (discussed in Section 2.2) is examined using OLS (Ordinary Least Square) regression.

4. Results and discussion

4.1. *Stresses perceived by the community*

Table 2 shows that increase in pollution (87%), trawlers (89.7%) and change in climate (84%) are the highest perceived stresses across the total survey sample. Increase in temperature is also perceived by a high percentage of respondents (68.5%). The number of fishermen perceiving decrease in mangroves (35.1%) and rain (27.8%) are the least.

Fig. 2 shows the percentage of respondents perceiving the various stresses in the urban, semi-urban and rural communities. Among the urban community, pollution is the highest perceived stress (89.5%). In the semi-urban and rural community, increase in trawlers is the most perceived by the community (92% and 94% respectively). Decrease in mangroves is the least (8.5%) perceived by the urban fishermen. This low perception regarding declining mangroves possibly concurs with the literature which reports increase in mangrove forests in Mumbai and Maharashtra (Table 1). Nevertheless, 50.8% and 46% of the semi-urban and rural community perceive declining mangroves. Hence, it is considered as a stress in this study. Change in climate (89%) as well as

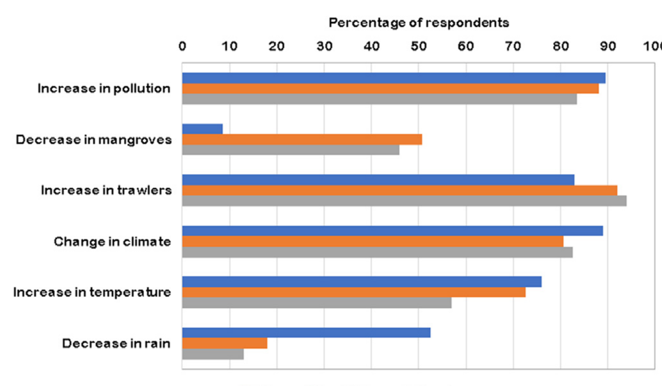

Fig. 2. Percentage of respondents perceiving the different stresses.

increase in temperature (76%) and decrease in rain (52.5%) are perceived the most by the urban community among the three regions. This shows that the urban community is the most aware about change in climate and its constituent variables, that is, temperature and rain. The FGDs also indicated that the urban fishermen are highly aware about changes in climate. Without being prompted by the facilitators, many of the participants described the threats of global warming and sea level rise on coastal communities. Decrease in rain is the least perceived by the semi-urban (17.9%) and rural (13%) community. It is seen that perceptions of change in climate is higher than perceptions of change in

Table 3
Parameter estimates of the logistic regressions.

	Increase in pollution		Decrease in mangroves		Increase in trawlers		Change in climate		Increase in temperature		Decrease in rain	
	Coefficient	Marginal effect	Coefficient	Marginal effect	Coefficient	Marginal effect	Coefficient	Marginal effect	Coefficient	Marginal effect	Coefficient	Marginal effect
Region	−0.899**	−0.032**	0.714***	0.137***	0.999***	0.074***	−0.896***	−0.035**	−0.345**	−0.067***	−1.349***	−0.202***
Level of education	0.133	0.005	−0.208	−0.040	−0.085	−0.006	−0.054	−0.002	0.246***	0.048***	0.087*	0.013*
Years of experience	0.025	0.001	0.020**	0.004**	−0.001	0.000	0.020	0.001	0.031***	0.006***	0.046***	0.007***
No. of family members who fish together	−0.110	−0.004	0.160	0.031	−0.178	−0.013	0.204	0.008	0.025	0.005	−0.064	−0.010
Income from fishing per month	0.000**	0.000**	0.000	0.000	0.000	0.000	0.000	0.000	0.000***	0.000***	0.000***	0.000***
Type of boat	0.230	0.008	−0.575***	−0.110***	0.094	0.007	0.580*	0.022*	−0.279	−0.054	0.186	0.028
Length of a trip in hours	−0.002	0.000	0.004***	0.001***	−0.001	0.000	−0.001	0.000	0.000	0.000	0.007	0.001
Number of fishing months in a year	−0.101	−0.004	0.068	0.013	−0.246	−0.018	0.222*	0.009*	0.034	0.007	−0.023	−0.003
Know to use internet	1.595	0.058	0.512	0.098	0.409	0.030	0.742	0.029	0.116	0.022	0.954***	0.143***
Constant	−0.188		−0.474		2.678*		−1.915		0.828		0.047	
Pseudo-R^2	0.169		0.218		0.139		0.088		0.136		0.337	

* Significant at 90% confidence level.
** Significant at 95% confidence level.
*** Significant at 99% confidence level.

temperature and rain in all three communities. This indicates that it is comparatively difficult for the community to comprehend changes in specific variables than the overall climate.

4.2. Factors associated with the perceptions of stresses

Table 3 shows the results of the binary logistic regressions. The goodness of fit (Hosmer-Lemeshow) tests indicated that all the regression models are significant.

Perception of all stresses considerably varies among the urban, semi-urban and rural communities as indicated by a significant coefficient for the variable ‘Region’ (the differences in stress perceptions among the three regional communities are described in detail in Section 4.1). Additionally, region has the highest marginal effect among all the factors influencing perception of each of the stresses. The coefficients and marginal effects show that perceptions of pollution vary mostly with region and very negligibly with income. Regional differences in pollution levels may exist because of different levels of industrialization and urbanization. Further, as pollution is highly visually unavoidable, region remains the most dominant factor influencing pollution perceptions. The same applies to perceptions of increasing trawlers which is only influenced by regional background.

Education is related to perceptions of increased temperatures and decreased rain. Experience is important for perceiving increased temperatures, decreased rain and decreased mangroves. It is interesting to note that education does not influence perceptions of any of the non-climatic stresses. Experience is solely related to perceptions of declining mangroves among all the non-climatic stresses. As discussed in Table 1, the literature states that mangrove cover has slightly increased in many parts of the state. Despite this, experience being positively related to mangroves indicates that elder fishermen perceive decreasing mangroves over years compared to the younger ones, who are only acquainted with recent changes.

Further, neither education nor experience is related to perceptions of climate change. But both of these variables are significantly associated with perceptions of increase in temperature and decrease in rain. Thus, both education and experience is required to perceive long-term change in the constituent variables of climate, that is, temperature and rain.

Income is associated with perceptions of increase in pollution, temperature and decrease in rain. But income has negligible influence on these perceptions as indicated by its low marginal effect.

The type of boat is negatively associated with perceptions of declining mangroves. This indicates that non-motorized boats (coded as 1), which generally fish near the coast and mangroves, are more likely to perceive decreasing mangroves. Boat type is positively associated with perceptions of climate change indicating that advanced mechanized boat (coded as 3) owners have a greater likelihood of perceiving it.

Fishermen, whose fishing trips are lengthy and who are more involved, perceive decreasing mangroves. On the other hand, fishermen who fish for greater number of months in a year perceive climate change. This may suggest that fishermen who fish in different seasons over months are more likely to perceive long-term changes in climate over years. But, both variables ‘Length of trip in hours’ and ‘Number of fishing months in a year’ have the lowest marginal effect among all the factors on perceptions of decreasing mangroves and climate change respectively. Further, the variable ‘Number of fishing months in a year’ is not significant for perceiving change in temperature and rain (although it is significant for perceiving climate change). Perhaps, the other factors, such as region, education, experience and income, can better explain the variance in perceptions of temperature and rain.

Usage of internet is solely associated with perceptions of declining rainfall. A marginal effect of 0.143 indicates that it has a high influence on perceptions of rain after ‘region’. Lastly, ‘Number of family members who fish together’, a form of social capital, does not affect perception of any of the stresses.

Table 4
Factor analysis of perception of stresses.

		Factor loading		Communality
		Factor 1(Climatic stresses)	Factor 2(Non-climatic stresses)	
Variable	Increase in pollution	−0.118	**0.404**	0.177
	Decrease in mangroves	−0.405	**0.589**	0.512
	Increase in trawlers	−0.155	**0.705**	0.521
	Increase in temperature	**0.721**	0.352	0.644
	Decrease in rain	**0.801**	0.177	0.673
Model Summary	Eigenvalue	1.36	1.16	2.52
	Percentage of Variance	27.28	23.27	50.55

Thus, it is observed that perception of decreasing rainfall and increasing trawlers has the highest and lowest number of significant drivers respectively.

4.3. Stress perception index

CATPCA of the perception of various stresses results in two factors with eigenvalues greater than 1 (Table 4). These two factors are able to explain a total variance of 50.55%. The first factor appears to represent the climatic stresses, that is, increase in temperature and decrease in rain. This is indicated by the higher loadings of these two climate variables on factor 1 (highlighted in bold in Table 4). The second factor seems to correspond to non-climatic or general stresses, that is, increase in pollution, decrease in mangroves and increase in trawlers. The same can also be interpreted from Fig. 3. This plot of the factor loadings shows that the climatic and non-climatic stresses are separated and fall on either side of the origin. This indicates that the loading of these two types of stresses on the two factors vary. The communalities listed in Table 4 show that the variance in perception of rain and pollution are the most (0.673) and least (0.177) explained by the factors respectively.

Further, the scores from the two factors for each of the respondent are compared. It shows that only 3.33% have greater scores from factor 1 than 2. This indicates that only 3.33% perceive greater risks from climatic than the non-climatic/general stresses. Thus, a majority of fishermen perceive non-climatic stresses to be more consequential for their livelihoods than climate change. The same can also be inferred from Table 6 where the average scores from the non-climatic stresses is greater than that from the climatic stresses in the urban, semi-urban and rural communities.

Table 2 shows that the average stress index is 0.9 and ranges from 0 to 1.5.

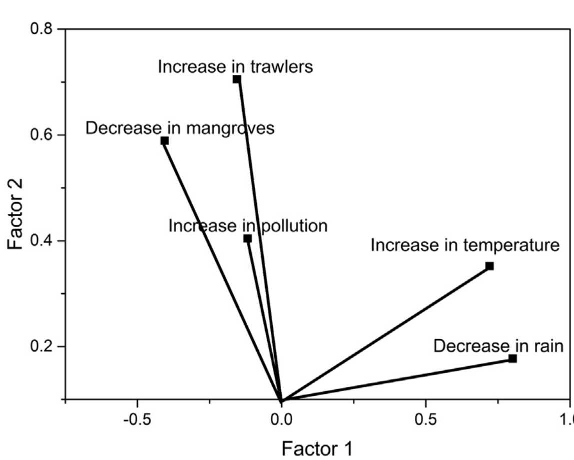

Fig. 3. Plot of the factor loadings.

Table 5
Parameter estimates of regression with stress perception index as dependent variable.

	Coefficient
Region	−0.117*** (0.023)
Level of education	0.030*** (0.010)
Years of experience	0.007*** (0.001)
No. of family members who fish together	−0.002 (0.020)
Income from fishing per month	0.000*** (0.000)
Type of boat	−0.014 (0.032)
Length of a trip in hours	0.001** (0.000)
Number of fishing months in a year	−0.007 (0.010)
Know to use internet	0.091** (0.039)
Constant	1.006*** (0.166)
Adjusted R^2	0.135

Robust standard errors in parenthesis.
** Significant at 95% confidence level.
*** Significant at 99% confidence level.

4.4. Factors associated with stress perception index

The OLS regression results (Table 5) indicate that the stress perception indices significantly vary among the three regions. The coefficients further suggest that region has highest influence on the index. An inspection into the average stress indices for the regions (Table 6) reveal that the urban community (1.01) has the highest perception of the stresses, followed by the semi-urban (0.86) and rural (0.76) community. Scores from factor 1, which represent climatic stress, also indicate highest and lowest perceptions among the urban (0.70) and rural (0.06) community respectively. This perhaps indicates that the urban community has high level of awareness regarding climate change and its effects on their livelihoods. On the other hand, non-climatic stresses are most perceived by the semi-urban (1.64) community, followed by the rural (1.58) and urban (1.37) communities. This possibly suggests that the urban community, which has been enduring detrimental effects of development and urbanization since past few decades, do not perceive much change in the non-climatic or general stresses. But experiences of non-climatic stresses have been comparatively recent for the semi-urban and rural community, which has led to greater perception of these stresses.

Higher education, experience, fishing income, trip length and knowing usage of internet are the other factors significantly associated

Table 6
Average scores from the factors and stress perception index in the three regions.

	Urban	Semi-urban	Rural
Average scores from factor 1 (Climatic stresses)	0.70	0.20	0.06
Average scores from factor 2 (Non-climatic stresses)	1.37	1.64	1.58
Average stress perception index	1.01	0.86	0.76

with the stress perception index. The coefficients indicate that income has the least effect on the index. Following region, internet usage and education are some of the highest influencing factors.

5. Conclusion

A variety of stresses affect livelihoods of marine fishermen. Awareness regarding these stresses can help communities make informed adaptation decisions. This study is an attempt to understand perceptions of these stresses among fishermen and the factors driving them. An array of methods, including literature review, FGDs and household survey, are used to identify the stresses predominant in the study area and subsequently the factors driving communities' perceptions. Increasing pollution and trawlers are the highest perceived non-climatic stresses. Climate change is also perceived by a vast majority of the fishermen. Thus, although affects of climate change on marine fishing is not much addressed by popular media in the developing world, a high percentage of the fishing community perceive it. But lower percentages of fishermen are able to perceive changes in the constituent parameters of climate, that is, temperature and rain. The FGDs and survey showed that the community is limited in its understanding of the impacts of global warming or increasing temperature (which can also impact chlorophyll concentrations and primary productivity of the oceans) on fish populations.

Further, it is found that both education and experience are significantly linked to perceptions of increasing temperature and decreasing rain. Experience is also important for perceiving changing mangrove cover, which has steadily decreased under pressures of urbanization and development over time. While non-motorized boats, which fish nearer to the coastline, perceive decreasing mangroves, advanced mechanized boat owners perceive changes in climate. Fishermen spending more number of hours in a trip are more likely to perceive decreasing mangroves. On the other hand, fishermen who fish for many months in a year and probably are able to observe impacts of seasonal variations on fish populations perceive changes in climate. Lastly, perception of all stresses significantly varies with regional backgrounds. The urban community comprise of the highest number of respondents perceiving pollution, change in climate, temperature and rain.

During the construction of the stress perception index, two factors are generated which explained the non-climatic/general and climatic stresses separately. It is observed that a large proportion of fishermen perceive non-climatic stresses, that is, increasing pollution, trawlers and decreasing mangroves, to be more adversely affecting their livelihoods compared to climate change. This is because these are the immediate and currently visible stresses in their livelihood. At present, there are policies to curb most of these stresses. For example, The Water (Prevention and Control of Pollution) Act 1974 seeks to control discharge of effluents and pollution in the sea [64] and The Coastal Regulation Zone Notification 2011 (under the Environment Protection Act 1986) mandates control of coastal pollution and protection of mangroves [65]. However, they need to be strictly implemented. Further, The Comprehensive Marine Fishing Policy 2004 envisages reserving fishing area for different boat types [66] such that competition for fish catch between small-scale fishers and trawlers can be controlled. Again, there is laxity in implementation of such policy measures [67,68]. The community opined that stricter measures, such as seasonal trawl bans and restrictions on number of trawlers that can be owned by a single fisherman, are needed to control the number of trawlers. Also, programmes need to be designed which inform the community about future changes in the climate, which can increase vulnerability of their livelihoods, and possible adaptation options. Provision of scientific knowledge to the community, such as impacts of change in rain, temperature, chlorophyll concentrations on fish populations, can also be useful for the community in making individual adaptation decisions.

The urban community has the highest stress perception index as well as leads in perceptions of climatic stresses (as indicated by the higher average scores from factor 1 in Table 6). The semi-urban and rural communities, which have perhaps been experiencing the general/non-climatic stresses comparatively later than the urban community, have higher averages from factor 2 (depicting non-climatic stresses in Table 6). The regression results show that the stress perception index significantly vary with region, education, experience, fishing income, trip length and knowing usage of internet. High coefficients for education and internet usage indicate that awareness programmes (regarding the multi-stresses affecting fishing livelihoods of the community) which consider providing their (education and internet) outreach can be beneficial. This can also be suggested from the significance of education for perceiving change in temperature and rain; and significance of internet usage for perceiving changes in rainfall.

This paper aids the understanding of subjective perceptions of stresses in marine fishing livelihoods and the factors driving them. Future studies can examine other relevant factors which might affect perceptions based on the study context and region. They can also investigate the strength or different scales of perceptions about the stresses. Further, studies which examine perceptions of the stresses among government authorities and policymakers can complement the results of the present study [20]. Such studies reporting on beliefs and perceptions of various stakeholders can provide a baseline for discussion and can be helpful for initiating policy dialogues.

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References

[1] T. Daw, W.N. Adger, K. Brown, Climate change and capture fisheries: potential impacts, adaptation and mitigation, in: K. Cochrane, C. Dee Yong, D. Soto, T. Bahri (Eds.), Climate Change Implications for Fisheries and Aquaculture: Overview of Current Scientific Knowledge, FAO Fisheries and Aquaculture Technical Paper. No. 530, FAO, Rome, 2009, pp. 107–153.

[2] O. Hoegh-Guldberg, J.F. Bruno, The impact of climate change on the world's marine ecosystems, Science 328 (80-) (2010) 1523–1528, https://doi.org/10.1126/science.1189930.

[3] B.S. Halpern, S. Walbridge, K. a Selkoe, C.V. Kappel, F. Micheli, C. D'Agrosa, et al., A global map of human impact on marine ecosystems, Science 319 (2008) 948–952, https://doi.org/10.1126/science.1149345.

[4] M.S. Islam, M. Tanaka, Impacts of pollution on coastal and marine ecosystems including coastal and marine fisheries and approach for management: a review and synthesis, Mar. Pollut. Bull. 48 (2004) 624–649, https://doi.org/10.1016/j.marpolbul.2003.12.004.

[5] I. Nagelkerken, S.J.M. Blaber, S. Bouillon, P. Green, M. Haywood, L.G. Kirton, et al., The habitat function of mangroves for terrestrial and marine fauna: a review, Aquat. Bot. 89 (2008) 155–185, https://doi.org/10.1016/j.aquabot.2007.12.007.

[6] L. Piya, K.L. Maharjan, N.P. Joshi, Determinants of adaptation practices to climate change by Chepang households in the rural Mid-Hills of Nepal, Reg. Environ. Chang. 13 (2013) 437–447, https://doi.org/10.1007/s10113-012-0359-5.

[7] L. Roco, A. Engler, B.E. Bravo-Ureta, R. Jara-Rojas, Farmers' perception of climate change in mediterranean Chile, Reg. Environ. Chang. 15 (2015) 867–879, https://doi.org/10.1007/s10113-014-0669-x.

[8] K.A. Sullivan-Wiley, A.G.S. Gianotti, Risk perception in a multi-hazard environment, World Dev. 97 (2017) 138–152, https://doi.org/10.1016/j.worlddev.2017.04.002.

[9] G.A. Gbetibouo. Understanding farmers' perceptions and adaptations to climate change and variability: the case of the Limpopo Basin, South Africa, IFPRI discussion Paper. 00849, 2009, 52, ⟨https://www.doi.org/10.1068/a312017⟩.

[10] B. Legesse, L. Drake, Determinants of smallholder farmers' perceptions of risk in the Eastern Highlands of Ethiopia, J. Risk Res. 8 (2005) 383–416, https://doi.org/10.1080/1366987042000192426.

[11] T.M. Lee, E.M. Markowitz, P.D. Howe, C.Y. Ko, A.A. Leiserowitz, Predictors of public climate change awareness and risk perception around the world, Nat. Clim. Chang. 5 (2015) 1014–1020, https://doi.org/10.1038/nclimate2728.

[12] P.D. Howe, E.M. Markowitz, T.M. Lee, C.Y. Ko, A. Leiserowitz, Global perceptions of local temperature change, Nat. Clim. Chang. 3 (2013) 352–356, https://doi.org/10.1038/nclimate1768.

[13] M.F.W. Slegers, "If only it would rain": farmers' perceptions of rainfall and drought in semi-arid central Tanzania, J. Arid Environ. 72 (2008) 2106–2123, https://doi.

org/10.1016/j.jaridenv.2008.06.011.
[14] C.H. Quinn, M. Huby, H. Kiwasila, J.C. Lovett, Local perceptions of risk to livelihood in semi-arid Tanzania, J. Environ. Manag. 68 (2003) 111–119, https://doi.org/10.1016/S0301-4797(03)00013-6.
[15] J. Burger, M. Gochfeld, Fishing a superfund site: dissonance and risk perception of environmental hazards by fishermen in Puerto Rico, Risk Anal. 11 (1991) 269–277, https://doi.org/10.1111/j.1539-6924.1991.tb00603.x.
[16] J. Burger, K. Staine, Fishing in contaminated waters: knowledge and risk perception of hazards by fishermen in New York City, J. Toxicol. Environ. Health 39 (1993) 95–105, https://doi.org/10.1080/15287399309531738.
[17] M. Nursey-Bray, G.T. Pecl, S. Frusher, C. Gardner, M. Haward, A.J. Hobday, et al., Communicating climate change: climate change risk perceptions and rock lobster fishers, Tasmania, Mar. Policy 36 (2012) 753–759, https://doi.org/10.1016/j.marpol.2011.10.015.
[18] I.M. Martins, M.A. Gasalla, Perceptions of climate and ocean change impacting the resources and livelihood of small-scale fishers in the South Brazil Bight, Clim. Change (2018) 1–16, https://doi.org/10.1007/s10584-018-2144-z.
[19] D. Karnad, M. Gangal, K.K. Karanth, Perceptions matter: how fishermen's perceptions affect trends of sustainability in Indian fisheries, Oryx 48 (2014) 218–227, https://doi.org/10.1017/S0030605312001251.
[20] J. Horowitz, R.L. Pressey, G.G. Gurney, A.S. Wenger, K.A. Pahang, Investigating stakeholder perceptions of fish decline: making sense of multiple mental models, Sustainability 10 (2018) 1–26, https://doi.org/10.3390/su10041222.
[21] M.A.R. Hossain, M. Ahmed, E. Ojea, J.A. Fernandes, Impacts and responses to environmental change in coastal livelihoods of south-west Bangladesh, Sci. Total Environ. 637–638 (2018) 954–970, https://doi.org/10.1016/j.scitotenv.2018.04.328.
[22] K. Malakar, T. Mishra, A. Patwardhan, A framework to investigate drivers of adaptation decisions in marine fishing: evidence from urban, semi-urban and rural communities, Sci. Total Environ. 637–638 (2018) 758–770, https://doi.org/10.1016/j.scitotenv.2018.04.429.
[23] V.W.Y. Lam, W.W.L. Cheung, G. Reygondeau, U.R. Sumaila, Projected change in global fisheries revenues under climate change, Nat. Publ. Gr. (2016) 6–13, https://doi.org/10.1038/srep32607.
[24] U.R. Sumaila, W.W.L. Cheung, V.W.Y. Lam, D. Pauly, S. Herrick, Climate change impacts on the biophysics and economics of world fisheries, Nat. Clim. Chang. 1 (2011) 449–456, https://doi.org/10.1038/nclimate1301.
[25] IPCC, Climate Change 2014: Synthesis Report. Contribution of Working Groups I, II and III to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change [Core Writing Team, R.K. Pachauri and L.A. Meyer (eds.)], IPCC, Geneva, Switzerland, 2014. 〈https://www.ipcc.ch/pdf/assessment-report/ar5/syr/SYR_AR5_FINAL_full.pdf〉 (Accessed 26 June 2016).
[26] A.B. Kumar, G.R. Deepthi, trawling and by-catch: implications on marine trawling and by-catch: Implications on marine ecosystem, Curr. Sci. 90 (2006).
[27] M.L. Stiles, J. Stockbridge, M. Lande, M.F. Hirshfield, Impacts of bottom trawling on fisheries, Tour. Mar. Environ. Ocean. 12 (2010), 〈http://oceana.org/reports/impacts-bottom-trawling-fisheries-tourism-and-marine-environment〉.
[28] A.M. Hoguane, E. da, L. Cuamba, T. Gammelsrød, Influence of rainfall on tropical coastal artisanal fisheries – a case study of Northern Mozambique, J. Integr. Coast. Zo Manag. 12 (2012) 477–482, https://doi.org/10.5894/rgci338.
[29] M. Shohidullah Miah, Climatic and anthropogenic factors changing spawning pattern and production zone of hilsa fishery in the bay of bengal, Weather Clim. Extrem. 7 (2015) 109–115, https://doi.org/10.1016/j.wace.2015.01.001.
[30] J. McIlwain, G.V. Hermosa, M. Claereboudt, H.S. Al-Oufi, M. Al-Awi, Spawning and reproductive patterns of six exploited finfish species from the Arabian Sea, Sultanate of Oman, J. Appl. Ichthyol. 22 (2006) 167–176.
[31] AWI, Litter is present throughout the world’s oceans: 1,220 species affected, Litterbase. 2017. 〈https://www.awi.de/nc/en/about-us/service/press/press-release/litter-is-present-throughout-the-worlds-oceans-1220-species-affected.html〉 (Accessed 3 December 2017).
[32] D. Boga, Mumbai marine life on deathbed, thanks to govt apathy, Dna. 2013. 〈http://www.dnaindia.com/mumbai/report-mumbai-marine-life-on-deathbed-thanks-to-govt-apathy-1838753〉 (Accessed 3 July 2015).
[33] M. Eriksen, L.C.M. Lebreton, H.S. Carson, M. Thiel, C.J. Moore, J.C. Borerro, et al., Plastic pollution in the world's oceans: more than 5 trillion plastic pieces weighing over 250,000 t afloat at sea, PLoS One 9 (2014) 1–15, https://doi.org/10.1371/journal.pone.0111913.
[34] DNANews Service, After oil spill in Uran, fishermen want ONGC to pay for their losses, Dna. 2013. 〈http://www.dnaindia.com/mumbai/report-after-oil-spill-in-uran-fishermen-want-ongc-to-pay-for-their-losses-1900762〉 (Accessed 3 July 2015).
[35] S. Sahu, H. Suresh, I. Murthy, N. Ravindranath, Mangrove area assessment in India: implications of loss of mangroves, J. Earth Sci. Clim. Change 06 (2015), https://doi.org/10.4172/2157-7617.1000280.
[36] FSI, State of Forest Report India 2015, Dehradun. 〈http://fsi.nic.in/details.php?PgID=sb_62〉.
[37] C. Lewis, Mangrove cover grows 20% in Maharashtra in 2 years, Times of India. 2015. 〈https://timesofindia.indiatimes.com/home/environment/flora-fauna/Mangrove-cover-grows-20-in-Maharashtra-in-2-years/articleshow/50059974.cms〉.
[38] P. Mallick, R. Survase, M.S. Dhuri, Coastal zone analyses around Mumbai – Thane coast using multitemporal satellite data and GIS, Int. J. Appl. Res. 1 (2015) 936–946.
[39] V. Patil, A. Singh, N. Naik, S. Unnikrishnan, P. Khale, Change detection analysis of mangrove for effective implementation of coastal zone management plan, J. Environ. Res. Dev. 9 (2015) 1225–1233.
[40] E. Vaz, Managing urban coastal areas through landscape metrics: an assessment of Mumbai's mangrove system, Ocean Coast. Manag. 98 (2014) 27–37, https://doi.org/10.1016/j.ocecoaman.2014.05.020.
[41] A.B. Telave, S.D. Ghodake, G.P. Pawar, Studies on area assessment under mangroves of Raigad district, Maharashtra, India, Indian For. 143 (2017) 207–212 〈http://www.indianforester.co.in/index.php/indianforester/article/view/113620〉.
[42] CMFRI, Maharashtra Marine Fisheries Census 2010, Kochi, India, 2010. 〈http://eprints.cmfri.org.in/9007/1/MH_report_full.pdf〉.
[43] CMFRI, Maharashtra Marine Fisheries Census 2005, Kochi, India, 2005. 〈http://eprints.cmfri.org.in/5531/1/11_Maharashtr_marine_census_2005.pdf〉.
[44] A. Kanti, How sustainable is the fishing industry in India? Businessworld (2017), 〈http://businessworld.in/article/How-Sustainable-Is-The-Fishing-Industry-In-India-/20-04-2017-116747/〉.
[45] D. Karnad, K.K. Karanth, Declining Indian Fisheries: Perceptions of Fisher Folk from Maharashtra and Tamil Nadu, Conserv. India, 2016. 〈http://www.conservationindia.org/articles/declining-indian-fisheries-perceptions-of-fisher-folk-from-maharashtra-and-tamil-nadu〉 (Accessed 21 December 2016).
[46] S.P. Kumar, R.P. Roshin, J. Narvekar, P.K.D. Kumar, E. Vivekanandan, Response of the Arabian Sea to global warming and associated regional climate shift, Mar. Environ. Res. 68 (2009) 217–222, https://doi.org/10.1016/j.marenvres.2009.06.010.
[47] N. Nandkeolyar, M. Raman, G.S. Kiran, Comparative Analysis of Sea Surface Temperature Pattern in the Eastern and Western Gulfs of Arabian Sea and the Red Sea in Recent Past Using Satellite Data, Int. J. Oceanogr. 2013 (2013).
[48] E. Vivekanandan, M. Rajagopalan, N.G.K. Pillai, Recent trends in sea surface temperature and its impact on oil sardine, in: P.K. Aggarwal (Ed.), Glob. Clim. Chang. Indian Agric. ICAR, New Delhi, 2009, pp. 89–92 〈http://eprints.cmfri.org.in/8435/1/Global_Climate_Change_Vivekanandan_89-92.pdf〉.
[49] P. Prakash, S. Prakash, H. Rahaman, M. Ravichandran, S. Nayak, Is the trend in chlorophyll-a in the Arabian Sea decreasing? Geophys. Res. Lett. 39 (2012) 1–7, https://doi.org/10.1029/2012GL054187.
[50] M.K. Roxy, A. Modi, R. Murtugudde, V. Valsala, S. Panickal, S. Prasanna Kumar, et al., A reduction in marine primary productivity driven by rapid warming over the tropical Indian Ocean, Geophys. Res. Lett. 43 (2016) 826–833, https://doi.org/10.1002/2015GL066979.
[51] E. Popova, A. Yool, V. Byfield, K. Cochrane, A.C. Coward, S.S. Salim, et al., From global to regional and back again: common climate stressors of marine ecosystems relevant for adaptation across five ocean warming hotspots, Glob. Chang. Biol. 22 (2016) 2038–2053, https://doi.org/10.1111/gcb.13247.
[52] R. Murtugudde, R. Seager, P. Thoppil, Arabian Sea response to monsoon variations, Paleoceanography 22 (2007) 1–17, https://doi.org/10.1029/2007PA001467.
[53] V. Parvathi, I. Suresh, M. Lengaigne, T. Izumo, J. Vialard, Robust projected weakening of winter monsoon winds over the Arabian Sea under climate change, Geophys. Res. Lett. 44 (2017) 9833–9843, https://doi.org/10.1002/2017GL075098.
[54] S. Lata, P. Nunn, Misperceptions of climate-change risk as barriers to climate-change adaptation: a case study from the Rewa Delta Fiji, Clim. Change 110 (2012) 169–186, https://doi.org/10.1007/s10584-011-0062-4.
[55] D.E. Sahn, D.C. Stifel, Urban-rural inequality in living standards in Africa (2004).
[56] S. Sarkar, B.S. Mehta, Income inequality in India:pre- and post-reform periods, Econ. Polit. Wkly. 45 (2010) 45–55 〈http://www.networkideas.org/news/feb2004/news09_Income_inequality.htm〉.
[57] E. Huddart-Kennedy, T.M. Beckley, B.L. McFarlane, S. Nadeau, Rural-urban differences in environmental concern in Canada, Rural Sociol. 74 (2009) 309–329, https://doi.org/10.1526/003601109789037268.
[58] L.C. Hamilton, B.D. Keim, Regional variation in perceptions about climate change, Int. J. Climatol. 29 (2009) 2348–2352, https://doi.org/10.1002/joc.
[59] Pew Research Center, Global warming: a divide on causes and solutions, Washington, D.C. 2007, 〈http://www.people-press.org/2007/01/24/global-warming-a-divide-on-causes-and-solutions/1/〉.
[60] P.S. Adler, S. Kwon, Social capital: prospects for a new concept, Acad. Manag. Rev. 27 (2002) 17–40.
[61] Ö. Bodin, B.I. Crona, The role of social networks in natural resource governance: what relational patterns make a difference? Glob. Environ. Chang. 19 (2009) 366–374, https://doi.org/10.1016/j.gloenvcha.2009.05.002.
[62] A. Anderson, Media, politics and climate change: towards a new research Agenda, Sociol. Compass 3 (2009) 166–182, https://doi.org/10.1111/j.1751-9020.2008.00188.x.
[63] J.C. Semenza, D.E. Hall, D.J. Wilson, B.D. Bontempo, D.J. Sailor, L.A. George, , Public perception of climate change. voluntary mitigation and barriers to behavior change, Am. J. Prev. Med. 35 (2008) 479–487, https://doi.org/10.1016/j.amepre.2008.08.020.
[64] MoEFCC Government of India, The Water (Prevention and Control of Pollution) Act 1974. 〈http://www.moef.nic.in/legis/water/wat1.html〉 (Accessed 2 January 2018).
[65] MoEFCC Government of India, Coastal Regulation Zone Notification 2011, New Delhi. 〈http://www.moef.nic.in/downloads/public-information/CRZ-Notification-2011.pdf〉.
[66] Government of India, Comprehensive Marine Fishing Policy, 2004. 〈http://dahd.nic.in/fishpolicy.htm〉 (Accessed 1 November 2015).
[67] P. Sudhakaran, Mechanized fishing boats violate rules, The Times of India, 2015. 〈http://timesofindia.indiatimes.com/city/kozhikode/Mechanized-fishing-boats-violate-rules/articleshow/49202828.cms〉 (Accessed 24 December 2016).
[68] The Guardian, India’s fishermen fall on tough times, Guard, 2008. 〈https://www.theguardian.com/world/2008/may/28/india-fishing〉 (Accessed 24 December 2016).